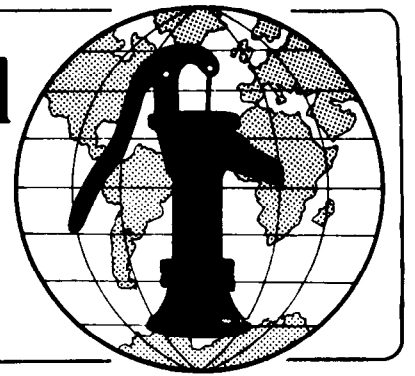


Water for the World

Designing Stabilization Ponds Technical Note No. SAN. 2.D.5



A stabilization pond is a large shallow excavation that receives sewage from a sewer system, detains the sewage so that biological processes can destroy most of the disease-causing organisms, and discharges the effluent as treated sewage. Designing a stabilization pond requires the help of an experienced engineer. It involves selecting a site; calculating pond size; and determining labor, materials, and tools needed for construction. The end-products of the design process are design drawings of the pond and its features, and a detailed materials list.

Table 1. Sample Materials List for Stabilization Pond

| Item | Description | Quantity | Estimated Cost |
|---------------------|--|----------------------|----------------|
| Labor | Construction foreman (experienced) | _____ | _____ |
| | Laborer (skilled with concrete) | _____ | _____ |
| | Laborer (skilled with heavy equipment) | _____ | _____ |
| | Laborers (unskilled) | _____ | _____ |
| | | _____ | _____ |
| Supplies | Sewer pipe (100mm diameter) | _____ m | _____ |
| | "T" fittings (100mm diameter) | _____ | _____ |
| | Valve | _____ | _____ |
| | Wire mesh (for outlet) | _____ m ² | _____ |
| | Cement | _____ m ³ | _____ |
| | Sand (for concrete) | _____ m ³ | _____ |
| | Gravel | _____ m ³ | _____ |
| | Water | _____ liters | _____ |
| | Gravel (for embankment) | _____ m ³ | _____ |
| | Grass seed (for embankment) | _____ | _____ |
| | Wood (for forms) | _____ | _____ |
| Tools and Equipment | Surveying equipment (transit, level, etc.) | _____ | _____ |
| | Tractor with front-end loader | _____ | _____ |
| | Shovels | _____ | _____ |
| | Rakes | _____ | _____ |
| | Trowel | _____ | _____ |
| | Mixing containers | _____ | _____ |
| | Hammer | _____ | _____ |
| | Saw | _____ | _____ |
| | Nails | _____ | _____ |
| | Other | _____ | _____ |

Total Estimated Cost = _____

This technical note describes the basic design features of a stabilization pond.

Materials Needed

A master map of the sewer system similar to Figure 1. See "Designing Sewer Systems," SAN.2.D.4.

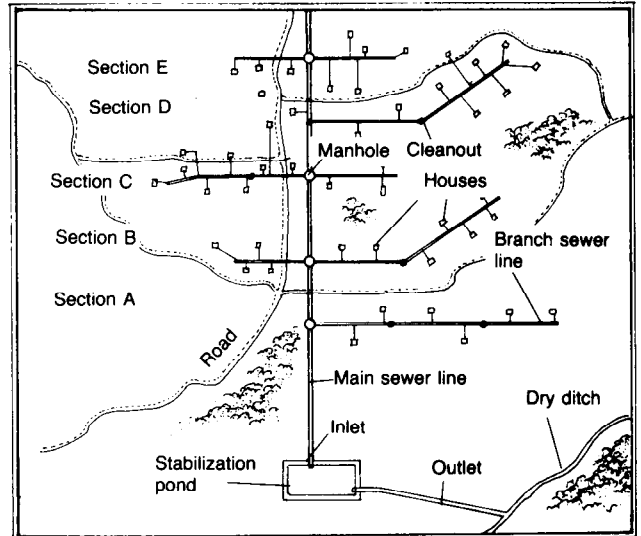


Figure 1. Master Sewer Map with Site of Stabilization Pond

Useful Definitions

EFFLUENT - Settled sewage.

GRAVITY FLOW - Flow of water from high ground to low by natural forces.

ORGANIC LOAD - The amount of organic material (expressed in grams per liter) present in sewage that must be acted upon in a stabilization pond before it can be discharged as treated sewage.

TREATED SEWAGE - The liquid that flows out of a stabilization pond (or series of ponds). Treated sewage is safer than settled sewage and may be used to irrigate crops not intended for human consumption.

Selecting a Site

1. Elevation. The site must be lower than the entire sewer system to allow for gravity flow of sewage into the pond. The outlet of the sewer system is the inlet into the pond. If

the site does not allow gravity flow, the sewage must be pumped, which requires costly equipment, energy and maintenance.

2. Soil. The soil must be able to hold a pond. It must not be sandy or made of loose soil and gravel that pass liquid. The site should be relatively easy to excavate, and there should be material at or near the site with which to build embankments.

3. Drainage. There must be good drainage away from the site to allow for the discharge of treated sewage. Often the treated sewage flows out of the pond into a dry stream bed or a waterway that is not used as a source of drinking water.

4. Size. The site must be large enough to accommodate the stabilization pond (see "Calculating Pond Size").

5. Flood protection. The site must not be in an area that is flooded during the wet season.

6. Distance. A stabilization pond should be no nearer to dwellings than 200m, and a larger distance is often desirable.

7. Wind direction. If possible, the site should be downwind from the community.

When the site has been selected, indicate it on the master sewer map, or draw a separate location map.

Calculating Pond Size

There are several ways to calculate pond size. Each method makes certain assumptions and requires different data. The method described here requires calculating the expected daily flow of sewage into the pond and determining the average annual water temperature in the area in degrees Celsius. See "Estimating Sewage or Washwater Flows," SAN.2.P.2. With these two facts at hand, the following formula can be used to find the minimum required surface area of the stabilization pond.

$$A = \frac{O.L. \times F}{M}$$

where A = minimum pond surface area expressed in square meters,

O.L. = organic load of sewage effluent expressed in grams per liter, and estimated at 0.5grams/liter for this example,

F = estimated daily flow of sewage entering the pond expressed in liters per day,

M = maximum allowable organic load expressed in grams per m² of pond surface per day, based on temperature and calculated with the following formula:

$$M = (2T - 12) \text{ grams/m}^2/\text{day}$$

where T = average annual water temperature expressed in degrees Celsius.

The formula can be rewritten:

$$A = \frac{(0.5\text{grams/liter}) \times (\text{liters/day})}{(2 \times \text{ }^\circ\text{C}) - 12\text{grams/m}^2/\text{day}}$$

For example, if the estimated daily flow of sewage effluent is 100,000 liters per day, and the average annual water temperature is 20°C, then the minimum surface area of the stabilization pond is:

$$\begin{aligned} A &= \frac{(0.5) \times (100,000)}{(2 \times 20) - 12} \\ &= \frac{50,000}{28} \\ &= 1785\text{m}^2 \end{aligned}$$

Stabilization ponds are generally rectangular, with the length two or three times as great as the width. A few examples of configurations for the above example would be:

$$\begin{aligned} \text{length} &= 60\text{m}; \text{width} = 30\text{m}; \\ \text{area} &= 60\text{m} \times 30\text{m} = 1800\text{m}^2 \end{aligned}$$

$$\begin{aligned} \text{length} &= 75\text{m}; \text{width} = 25\text{m}; \\ \text{area} &= 75\text{m} \times 25\text{m} = 1875\text{m}^2 \end{aligned}$$

The design depth of stabilization ponds varies from 1-3m depending on type of sewage, amount of sewage, and climatic conditions. For the type of pond discussed here, a depth of 1.25m may be used.

General Design Information

The inlet is a sewer pipe 100-300mm in diameter. It enters the pond about two thirds the pond length from the outlet end, and it rests on a base of concrete or stone. The bottom of the pipe is about 0.5m above the bottom of the pond.

The outlet is positioned in the center of one end of the pond. It is equipped with a "T" fitting, one or more sections of vertical sewer pipe, and a wire mesh screen to prevent surface debris from entering the pipe.

The embankment should be about 1.0m above the surface of the pond. Its sides should slope no steeper than 1 in 3 (one unit elevation for three units horizontal distance). The top of the embankment should be level and about 1.0m wide.

The inside corners of the pond should be rounded to prevent undue accumulation of floating material.

When the size and configuration of the pond have been determined, prepare design drawings similar to Figures 2 and 3. These should be given to the construction foreman before construction begins.

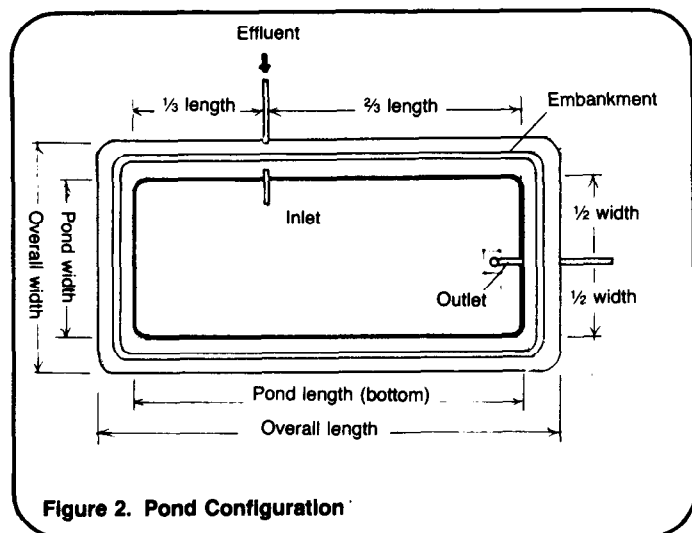


Figure 2. Pond Configuration

Determine whether a single pond or several ponds will be constructed. If several ponds are needed, see "Designing a System of Two or Three Stabilization Ponds," SAN.2.D.6.

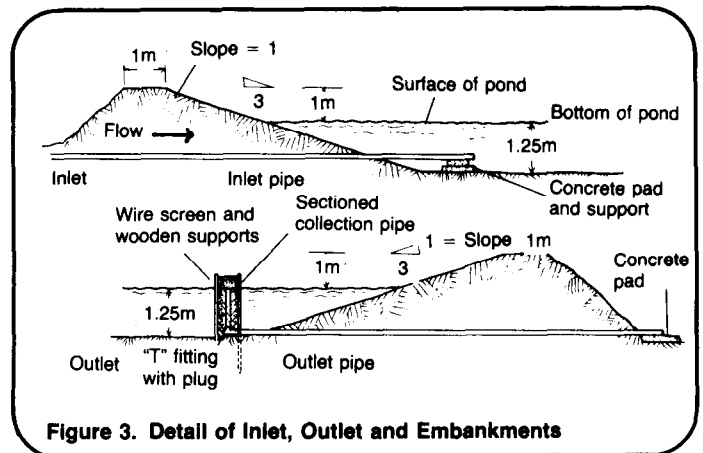


Figure 3. Detail of Inlet, Outlet and Embankments

Determining Labor, Materials, and Tools

The primary labor requirement is a construction foreman with experience in large-scale projects. Because field conditions and construction practices vary widely from region to region, the construction foreman should be involved in deciding on the requirements for labor, materials, and tools.

Because the elevation of the pond must be lower than all points on the sewer system, and the entire bottom of the pond must be fairly level, a surveyor may be needed. A fairly large and reliable work force of 5-20 laborers is required. Most workers may be unskilled. One or two should have some experience with concrete. One or more pieces of mechanized equipment, such as a tractor with a front-end loader, may be needed.

Materials needed include sewer pipe and fittings, concrete mortar mix, wire screen for the inlet and outlet, and gravel, grass seed, or sod to stabilize the embankments. Tools needed include those used for excavation, laying pipe, working with cement mortar, and spreading gravel and grass seed.

When labor, materials and tools have been decided upon, prepare a detailed materials list similar to Table 1 and give it to the construction foreman. In summary, give the construction foreman a map similar to Figure 1, design drawings similar to Figures 2 and 3, and a materials list similar to Table 1.